



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering (Part Time)

Subject Code: 2930903

Semester – III

Subject Name: Power System – I

Type of course: Professional Core Course

Prerequisite: NA

Rationale: Electrical power system is the backbone of modern society. It is these systems which are at the heart of everything humanity continues to accomplish. In view of this, understanding of basic elements of electrical power systems such as synchronous machine, transformer, transmission line, loads plays a vital role for the power system engineer. This subject deals with per unit system, corona, Over-voltages and Insulation Requirements, DC Transmission & Renewable Energy Systems.

Teaching and Examination Scheme:

| Teaching Scheme | | | Credits | Examination Marks | | | | Total Marks |
|-----------------|---|---|---------|-------------------|--------|-----------------|--------|-------------|
| L | T | P | | Theory Marks | | Practical Marks | | |
| | | | | ESE (E) | PA (M) | ESE (V) | PA (I) | |
| 3 | 0 | 2 | 4 | 70 | 30 | 30 | 20 | 150 |

Content:

| Sr. No. | Content | Total Hrs |
|---------|---|-----------|
| 1 | Basic Concepts : Evolution of Power Systems and Present-Day Scenario. Structure of a power system: Bulk Power Grids and Micro-grids. Generation: Conventional and Renewable Energy Sources. Distributed Energy Resources. Energy Storage. Transmission and Distribution Systems: Line diagrams, transmission and distribution voltage levels and topologies (meshed and radial systems). Synchronous Grids and Asynchronous (DC) interconnections. Review of Three-phase systems. Analysis of simple three-phase circuits. Power Transfer in AC circuits and Reactive Power. | 04 |
| 2 | Power System Components: Overhead Transmission Lines and Cables: Electrical and Magnetic Fields around conductors, Parameters of lines and cables. Capacitance and Inductance calculations for simple configurations. Sinusoidal Steady state representation of Lines: Short, medium and long lines. Travelling-wave Equations. Power Transfer, Voltage profile and Reactive Power. Characteristics of transmission lines. Surge Impedance Loading. Circle diagrams. Series and Shunt Compensation of transmission lines. Corona. Transformers: Three-phase connections and Phase-shifts. Three-winding transformers, | 25 |



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| | autotransformers, Neutral Grounding transformers. Tap-Changing in transformers. Transformer Parameters. Single phase equivalent of three-phase transformers. Synchronous Machines: Steady-state performance characteristics. Operation when connected to infinite bus. Real and Reactive Power Capability Curve of generators. Typical waveform under balanced terminal short circuit conditions – steady state, transient and sub-transient equivalent circuits. Loads: Types, Voltage and Frequency Dependence of Loads. Per-unit System and per-unit calculations. Neutral Grounding. | |
| 3 | Over-voltages and Insulation Requirements: Generation of Over-voltages: Lightning and Switching Surges. Protection against over voltages, Insulation Coordination. Propagation of Surges. Voltages produced by traveling surges. Bewley Diagrams. | 04 |
| 4 | Introduction to DC Transmission & Renewable Energy Systems : DC Transmission Systems: Line-Commutated Converters (LCC) and Voltage Source Converters (VSC). LCC and VSC based dc link, Real Power Flow control in a dc link. Comparison of ac and dc transmission. Solar PV systems: I-V and P-V characteristics of PV panels, Power electronic interface of PV to the grid. Wind Energy Systems: Power curve of wind turbine. Fixed and variable speed turbines. Permanent Magnetic Synchronous Generators and Induction Generators. Power Electronics interfaces of wind generators to the grid | 09 |

Suggested Specification table with Marks (Theory): (For BE only)

| Distribution of Theory Marks | | | | | |
|------------------------------|-----------|-----------|-----------|-----------|-----------|
| R Level | U Level | A Level | N Level | E Level | C Level |
| 20 | 20 | 20 | 30 | 10 | 00 |

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. J. Grainger and W. D. Stevenson, "Power System Analysis", McGraw Hill Education, 1994.
2. O. I. Elgerd, "Electric Energy Systems Theory", McGraw Hill Education, 1995



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3. A. R. Bergen and V. Vittal, "Power System Analysis", Pearson Education Inc., 1999
4. D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis", McGraw Hill Education, 2003
5. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, "Electric Power Systems", Wiley, 2012.

Course Outcomes:

| Sr. No. | CO statement | Marks % weightage |
|---------|--|-------------------|
| CO-1 | Calculate the inductance and capacitance parameters of the transmission line. | 20 |
| CO-2 | Analyze the steady state performance of the transmission line in interconnected power system. | 30 |
| CO-3 | Describe DC transmission, renewable energy systems, travelling surges, corona and design the transmission line based on corona phenomenon. | 30 |
| CO-4 | Evaluate important parameter of electrical power system and simulate power system elements using advanced computational software. | 20 |

List of Experiments:

- To calculate per unit value and draw one line diagram of simple power system.
- To calculate Capacitance and Inductance for simple transmission line conductor configurations.
- To obtain voltage regulation and efficiency of a short transmission line for different specified set of receiving end quantities (different load at leading, unity and lagging power factor).
- To write computer program for voltage regulation and efficiency of short transmission line for different specified set of receiving end quantities (different load at leading, unity and lagging power factor)
- To obtain voltage regulation and efficiency of a medium transmission line for different specified set of receiving end quantities (different load at leading, unity and lagging power factor).
- To write computer program to calculate voltage regulation and efficiency of a Medium transmission line (using π model & T model) for different specified set of receiving end quantities (different load at leading, unity and lagging power factor).
- To write computer program to calculate voltage regulation and efficiency of a Long transmission line using equivalent π model for different specified set of receiving end quantities (different load at leading, unity and lagging power factor).
- To plot sending end power circle diagram and receiving end power circle diagram of a transmission line on a graph paper with some suitable scale.
- To write a computer program for animation of travelling waves of a long transmission line with different operating conditions.
- To draw Bewley diagram for travelling wave.



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Major Equipments:

Softwares like MATLAB, C/C++, SciLab

List of Open Source Software/learning website:

- <http://www.scilab.org/>
- <http://www.gnu.org/software/octave/>
- <http://www.vlab.co.in>
- <http://nptel.ac.in>
- <https://ocw.mit.edu/index.htm>

Visits to power system installations (generation stations, EHV substations etc.) are suggested.